Logos Detection from Moving Vehicles

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Abstract: To deal with road accidents, especially accidents caused by trucks containing dangerous products, the possible solution is to control these vehicles' passage. We aim at developing a software technique confirming that all the entered engines inside a tunnel are securely quitted, to guarantee that no accidents, no breakdowns have occurred inside. To implement such solution, we identify the ingoing and outgoing trucks by extracting their significant marks. These marks help to differentiate each vehicle from the other. They are the mounted logos as license plates and pictograms. To ensure the safe exit of one truck, we look for the similarity between the ingoing and outgoing vehicle's images by comparing their detected symbols. In this paper, we present a controlling system capable to extract logos from moving trucks to verify their safe entrees and exits. Both theoretical analyses and experimental results are provided to show the performance of the proposed system.

1 INTRODUCTION

Most of the accidents happen in goods' road transport. At the same time, this sector supports nearly 75% of the total traffic in tones. In the case of hazardous product's transport, in addition to the usual consequences of transportation's accidents, can pop up the effects of the transported product. In fact, the dangerous materials' accident combines a primary effect immediately felt (fire, explosion, spills), and secondary effects (airborne spread of toxic fumes, water pollution or soil). Generally, a hazardous material is a substance that by its physical-chemical characteristics, toxicological, or the nature of its reactions can pose risks to the humans or the environment. In case of accident, it is essential for emergency services to be rapidly informed about the nature of the carried products in the immobilized vehicle. Consequently, a truck, carrying an unsafe substance, traveling on roads is always characterized by three types of logos:

-Rectangular plates, with numbers only, mounted in front and in the back of the vehicle. They are a 30x40 cm plates colored with a reflective orange and edged with a black border. The upper part, as mentioned in figure 1(a), provides information about the detailed characteristics of the material to quickly evaluate the risks. The lower part presents the identification number of the product registered as 4-digits number.

- Diamond-shape symbols, shown in figure 2, placed behind and on either sides of the vehicle. Named pictograms, they are various colored panels, having the shape of a 30 cm edge square. They report the major hazard of the substance.

-Rectangular plates, with numbers and letters, mounted in front and in the back of the vehicle. They are the license plates as shown in figure 1(b). They can be another characteristic that ameliorates the vehicle's unique identification. Almost, it's usually a 52x11 cm plate.

So that, all trucks have distinctive marks informing about the carried product, mounted at the front and the back. Exploiting these characteristics, we can extract logos from images taken for moving trucks while their entrees and their exits from a tunnel. The context of the existing problem is that trucks carrying hazardous materials circulating on the roads. The greatest risk occurs when a truck enters through a tunnel without living it. The purpose is to control these trucks and make sure that everyone is properly coming out. Otherwise, there was certainly an accident or breakdown that prevented its exit or delayed it. In this case the emergency services' intervention is obligatory. As solution, two cameras are placed one at the entrance, the other at the

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tunnel's exit. They provide videos taken for passing trucks. The developed system is based on images extracted from videos, to compare between the incoming and outgoing vehicles. This paper focuses on the logos' detection from moving vehicles.

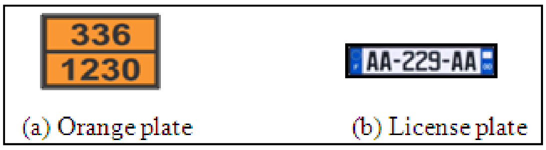


Figure 1: Example of plates.

Figure 2: Examples of pictograms' models.

Through the literature, we couldn't find previous works closely related to our subject. Almost, no one was interested in detecting logos from moving vehicle. The majority of the papers are concentrated separately in license plate recognition and road signs' extraction. As example, Kiran et al. in (Kiran et al., 2009), Paulo C et al in (Paulo and Correia, 008) present a vision based vehicle guidance system able to detect and recognize traffic signs. These papers deal with the detection and recognition of traffic signs from image sequences using the color information. The authors in (Malik et al., 2010); (Soheilian et al., 2010); (de la Escalera et al., 1997) present systems for the detection of road signs from a road scene image and extracts the pictogram inside the sign. (Chang et al., 2004); (Rahman et al., 2003); (Sunghoon et al., 2002); (Megalingam et al., 2010); (Tamer and Cizmeci, 2009) such as many other works propose different approaches of license plate recognition.

2 PROPOSED VEHICLES CONTROLLING SYSTEM OVERVIEW

The overall system's scheme takes as input two images of the truck (at the entrance and the exit) and generates as result a decision of similarity (a decisive score) between the two existing trucks in the pictures. In what follows, we will discuss the developed system as presented in figure 3 and explain its stages.

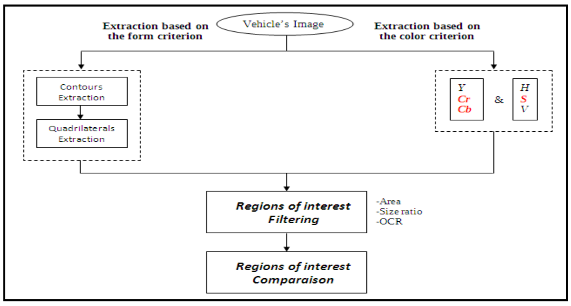


Figure 3: Developed system's stages.

2.1 Regions of Interest Extraction

In our case, the regions of interest are the plates and the diamond-shaped logos existing in the image. For this, we have to wonder how the eye can distinguish a logo in the image's universe. First of all, color plays an important part so it will be a decisional criterion in our technique. Then it is continuity, in fact, a logo is rarely a set of dispersed pixels but rather a contiguous area with a specific form. So, these particular features can be mainly classed in two types: the color and the shape. Therefore, we narrow our research in the image's areas that meet both criteria. We apply a double analysis to the vehicle's image: in the first one, we look for regions satisfying the color's criterion. At the second, we extract those with the required forms.

Regions of interest Extraction based on color criterion

The logos are quite different from the rest of the image. Their colors are limited to: saturated red, saturated orange, saturated yellow, saturated blue... We can distinguish that they almost vary between the red and blue colors' levels. In this case, RGB and YCrCb colors spaces are efficient for logos' extraction. YCrCb model provide low distance between two visually similar colors, while in RGB model they appear dissimilar. That's why, our choice converges to using the red Cr and blue Cb components of YCrCb color space. Since all the logos' colors are saturated, we enhance their extraction by using the saturation component S of the HSV model. In other words, we extract areas with highly saturated colors in the images. We classify every pixel in the image using this equation:

$$I_{(x,y)} \in \begin{cases} R \ if \ C_{r(x,y)} > T_r \ \ and \ \ S_{(x,y)} > T_s \\ B \ if \ C_{b(x,y)} > T_b \ \ and \ S_{(x,y)} > T_s \end{cases}$$

With :

$I_{(x,y)}$: Pixel of coordinates x and y of the image I.

C_r, C_b, : Red and blue component of YCrCb model and Saturation component of HSV model.

R, B : Red and blue classes.

T_r, T_b, T_S : fixed thresholds.

The thresholds are empirically fixed with a large number of images. Some results are shown in figure 4.

Regions of interest Extraction based on form criterion

The form is the second decisive criterion in regions of interest extraction. In plus, the previous step leads to false negative detections, where it can miss some logos because of their unsaturated color or for natural reasons: low luminosity, shadow superimposed, and plates with spots.... This magnifies the need for a second analysis based on the form. We can distinguish that the researched logos forms are limited to rectangle or rhombus. In this step, we look for the existing quadrilaterals in the image. We preprocess the image and find its contours. Then, we extract the closed contours which:

- Are convex
- Have four sides
- Have four right angles

Some results are presented in figure 5.

Regions of interest Filtering

The major problem of the extraction based on color criterion step is that the detected regions do not necessarily have the desired shapes. This detection leads to false positives that have unlooked-for shapes or are different from logos. Therefore, we apply an additional step for the rhombus and rectangles' extraction from the detected regions (examples of results are made in Figure 6). We scan the studied area trying to find the largest rectangle or rhombus with the highest percentage of the contours coverage.

The surface can be another characteristic for the regions filtering; a logo is always smaller than a truck in terms of area. So, all that is detected as too large is eliminated. As already mentioned in the first part, the searched logos have normalized dimensions, the height/width ratio is always invariant. So that, the size's ratio is also a discriminant characteristic. Filtering the detected zones based on area and size's ratio allows detecting only the regions most likely to be logos. At the end of this stage, we obtain the regions of interest representing the desired distinctive logos.

As shown in the introduction, the rectangular plates (orange or license plates) contain always textual information oppositely to the rhombus logos. Basing on this assumption, we can enhance our filtering by adding another characteristic: All rectangular plates without textual information and all diamond shaped logos with textual information are rejected. That's why; we use an optical character recognition system (OCR) to extract text from the logo's image.

a. Regions of interest Comparison

Each truck going in or out of the tunnel is characterized by all the logos extracted during the two first stages. The decision of similarity between two vehicles is taken by comparing their logos. The metric for measuring similarity will be the correspondence between these regions of interest. For this, we compute the correlation between two input and output images. We compare each logo from the first truck's image with all the others logos from the second one and select the most similar. The comparison is based on some criteria. For each criterion, a score is calculated to finally lead to an overall score which will decide whether the two images are representing the same truck or not. The comparison's criteria are:

-Matching score S_M : To measure the similarity between two logos, we use the Template Matching technique. We look for the small areas of an image that matches a pattern. So we scan the image from the left top to the bottom right searching for the best match with the model. At the end, we get a normalized score expressing the degree of resemblance.

-Histograms correlation S_H : For this metric, we compare the gray level histograms of both logos' images and calculate a similarity score.

-Areas ratio of the two logos S_A: The logo retains the same area between the two images. Having an areas' ratio close to 1, shows the correspondence between the two.

$$S_A = 1 - \frac{|A1-A2|}{\max(A1,A2)},$$

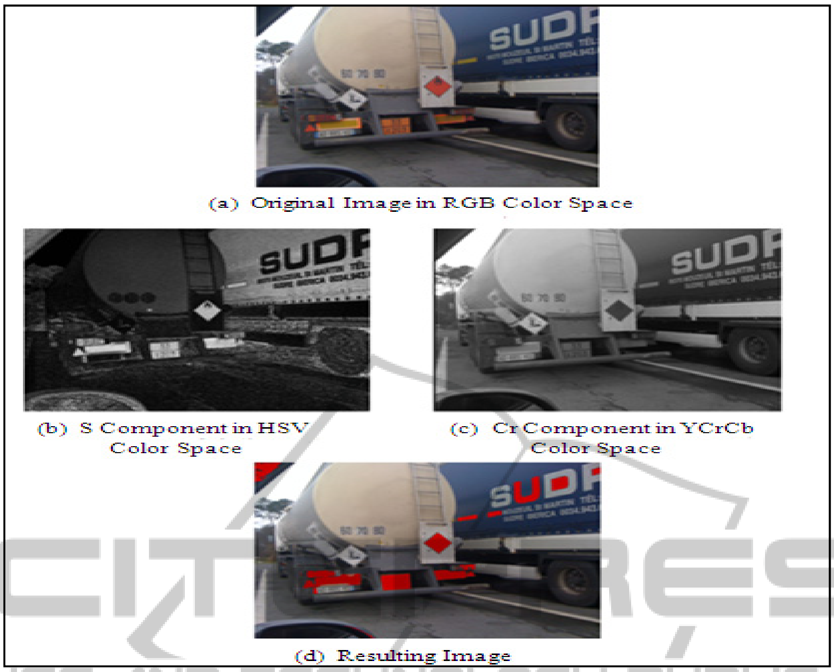
With A1 and A2 the areas of two images

-Ratio of length / width ratio of the two logos S_L: Just as the areas ratio, the length / width ratio is maintained. We aim at having a result close to 1 to ensure the similarity between the two thumbnails.

$$S_L := 1 - \frac{|R1-R2|}{\max(R1,R2)},$$

With R1 and R2 are the length / width ratio of the two logos

-Score of belonging to a class S_C: The score of correspondence between two logos is calculated as



(a) Original Image in RGB Color Space

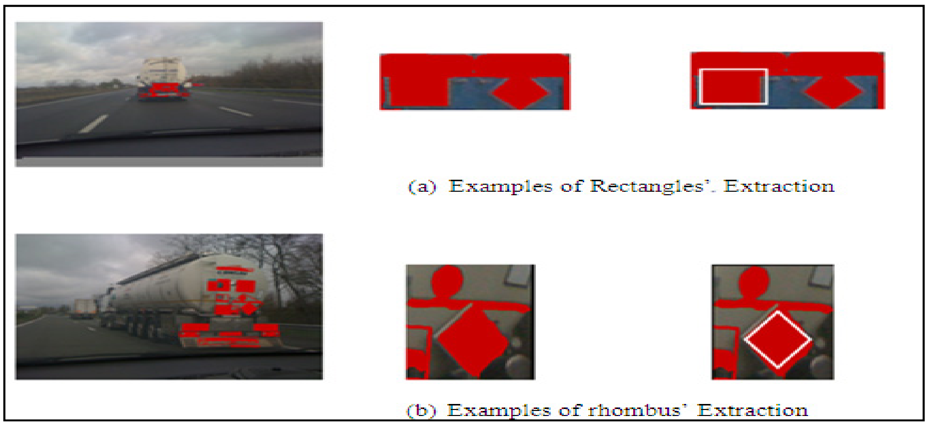
(b) S Component in HSV Color Space

(c) Cr Component in YCrCb Color Space

(d) Resulting Image

Figure 4: Results of logos detection based on the color criterion.

Figure 5: Results of logos detection based on the form criterion.



(a) Examples of Rectangles'. Extraction

(b) Examples of rhombus' Extraction

Figure 6: Results of extracting rectangles and rhombus from the detected regions.

follows:

$$S_C = \begin{cases} 1, \text{ if logo1 and logo2 are from the same class (both are plates, license plates, diamond shaped).} \\ 0.5, \text{ If Logo1 and Logo2 Have the Same Shape (One is a license plate and the other is an orange plate or vice versa)} \\ 0, \text{ if logo1 and logo2 have different shapes (one rectangle and one diamond or vice versa)} \end{cases}$$

Going through all the extracted regions of interest, we calculate a correlation score $S_{(I,J)}$ between each two. The highest score represents the most similar thumbnails. It is between 0 and 1 and calculated as follows:

Comparison scores between two thumbnail images I and J:

$$S_{(I,J)} = \frac{(S_M + S_H + S_A + S_L + S_C)}{5}$$

Thus, the overall score of similarity between two images S_G is derived by calculating the average of the best scores.

$$S_G = \frac{\sum S_{(I,J)}}{N},$$

With N: number of best scores obtained

3 RESULTS AND EVALUATION

We evaluate the proposed technique by testing different images of vehicles carrying hazardous products. Figure 7 shows some results. We can notice that almost 95% of the logos are correctly extracted. The false alarm rate, obtained after the two extraction processes, reaches nearly 5%. The detection failure (some examples are shown in figure 8) is mainly caused through the color detection's or the form detection's stage. Some cases are rejected such as a stretched logo due to the perspective effect or its small size, lack of lighting in the image, some logos are confused with the trucks taillights... For the regions of interest filtering stage, the used thresholds to decide whether the detected region have the right surface value or size's ratio are empirically fixed. It depends on the camera's zoom and its position in the tunnel. For the regions of interest comparing stage, the Table 1 compares the correlation's score between the regions extracted from a trucks input and output images. The best correlation's scores are in bold. The overall score obtained was 0.92, which proves that the same truck exists in both images. Note that the maximum scores obtained correspond to logos visually similar. The correct identification rate in this stage reaches 90%.

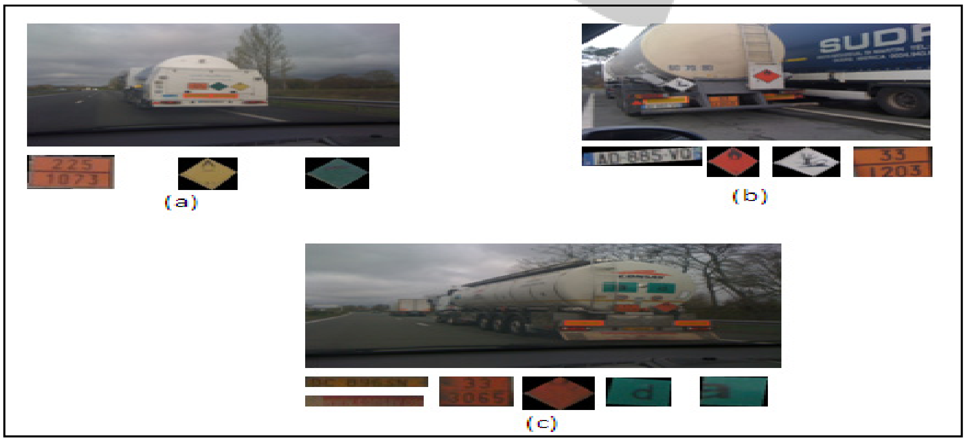
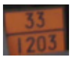


Figure 7: Regions of interest extraction results.

Figure 8: Examples of false negatives results.

Table 1: Correlation scores of logos extracted from two truck's images.

				
	**0,970**	0,442	0,2618	0,359
	0,445	**0,987**	0,3998	0,841
	0,336	0,239	**0,765**	0,191
	0,342	0,83	0,338	**0,984**

4 CONCLUSIONS

In this paper, we propose a logos' detection from moving vehicles technique. This system is developed as solution for safe hazardous products' transport. Using two images for same truck, at the tunnel's entree and exit, we control the vehicle and make sure it is properly coming out. Otherwise, there was certainly an accident or breakdown that prevented its exit or delayed it. This control system is based on three main stages: regions of interest extraction, regions of interest filtering and regions of interest comparing. Through experiments, we demonstrate that we succeed to achieve high detection and identification's rate.

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